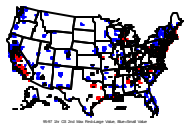
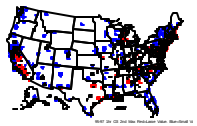


Monitoring Strategy:

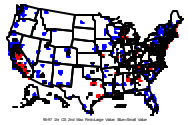


'National' Analysis

Who? What? When? Where? Why?

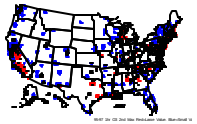
- Why was it done?
- What is it? (Methodology, Outputs)
- What does it show? (General Interpretations)
- Caveats / Criticisms
- Follow-up activities

Mark Schmidt
MQAG/EMAD/OAQPS
x2416



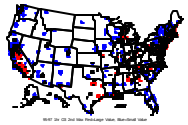
Monitoring Strategy:

'National' Analysis



Why do a National analysis?

- Show evidence of over-monitoring
  - Confirm belief that many sites are: low percent of NAAQS, redundant, too close to each other...
- Set stage for revised monitoring strategy
  - Flat funding / Changing priorities ~ Invest in new monitoring efforts (e.g., air toxics), divest in some criteria pollutant monitoring
- Spur Regional / Local analysis
  - National analysis are broad-bush and low-tech. Actual changes will result from more in-depth local analyses.
- Highlight general areas (geographic) of overkill



Monitoring Strategy:

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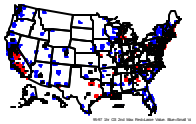
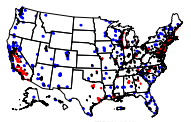


What is the National analysis?

- Evaluation of all criteria pollutant networks, all metrics (e.g., PM10 annual mean and 24-hr)
  - Three central pieces:
    1. Evaluation of each sites' 'percent of NAAQS'
    2. Multi-objective 'information value' approach ~ Shows relative value of each site according to different monitoring objectives ~ Ranked each site (by pollutant / metric) according to 5 measures [Concentration, Uncertainty, Deviation from NAAQS, Area represented by Site, & Population represented by site]. The measure rankings were then aggregated based on different weighting schemes and composite maps produced.
    3. Trends evaluation: Looked at 5-year and 10-year trends ('91-'00 & '96-'00)

Used 3-year avg. ('design value') of annual metric: used years 1998-2000 for all (and 1995-1997 for O3)

Monitoring Strategy:



'National' Analysis

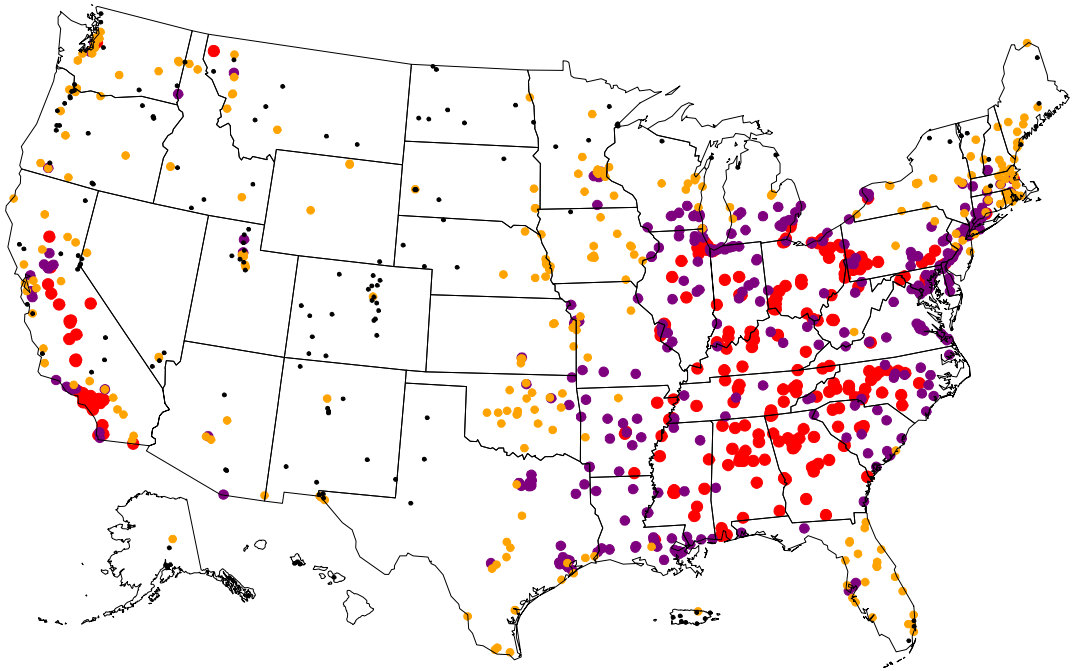
What is the National analysis? - Cont.

1. Evaluation of each sites' 'percent of NAAQS'

PM25 Annual Mean - Percent of NAAQS:

Red= >100%, Purple= 80-100%,

Orange= 60-80%, Black= <60%



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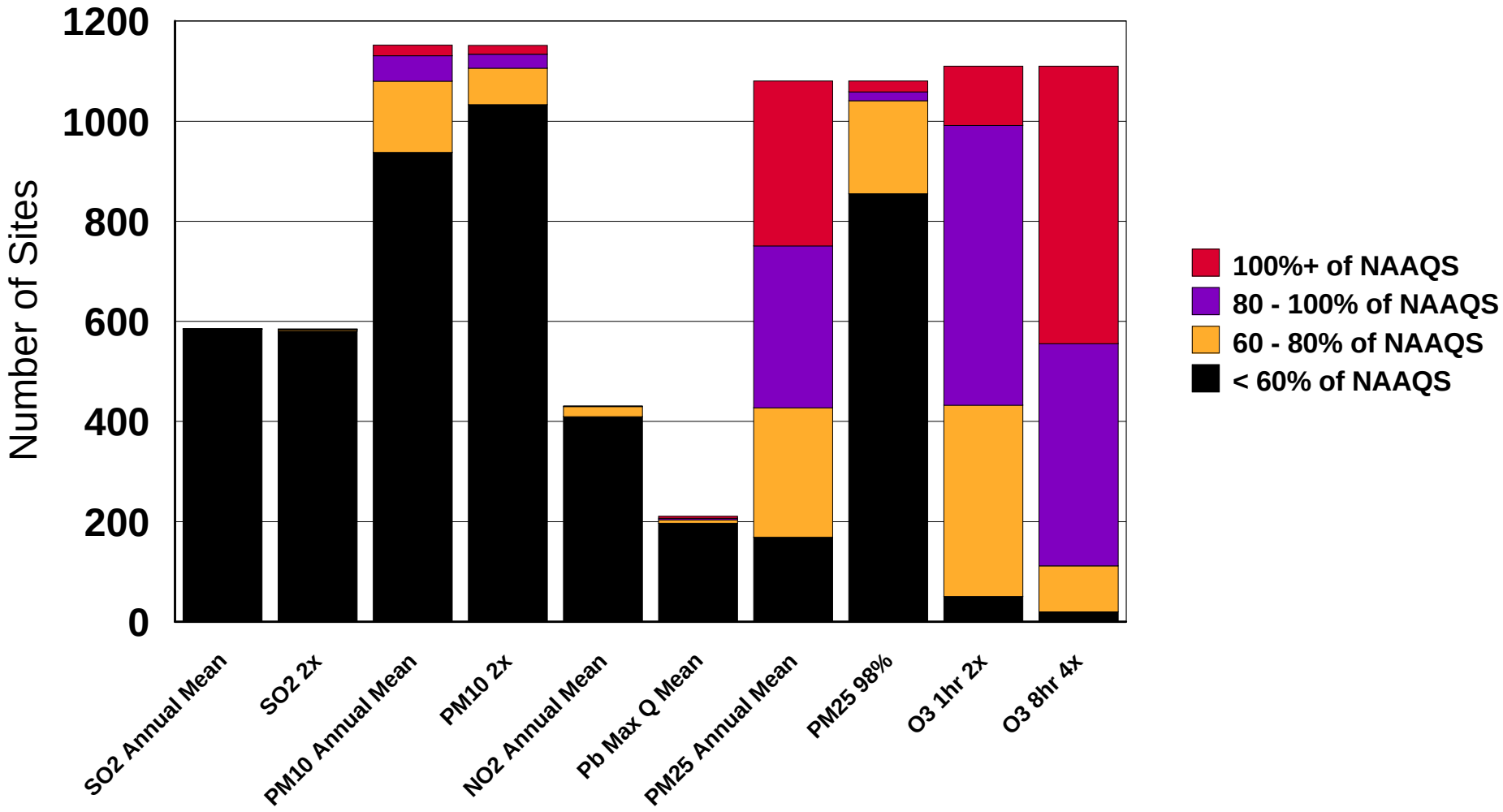
Monitoring Strategy:

'National' Analysis

What is the National analysis? - Cont.

1. Evaluation of each sites' ‘percent of NAAQS’



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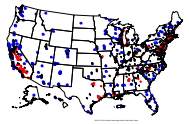


'National' Analysis

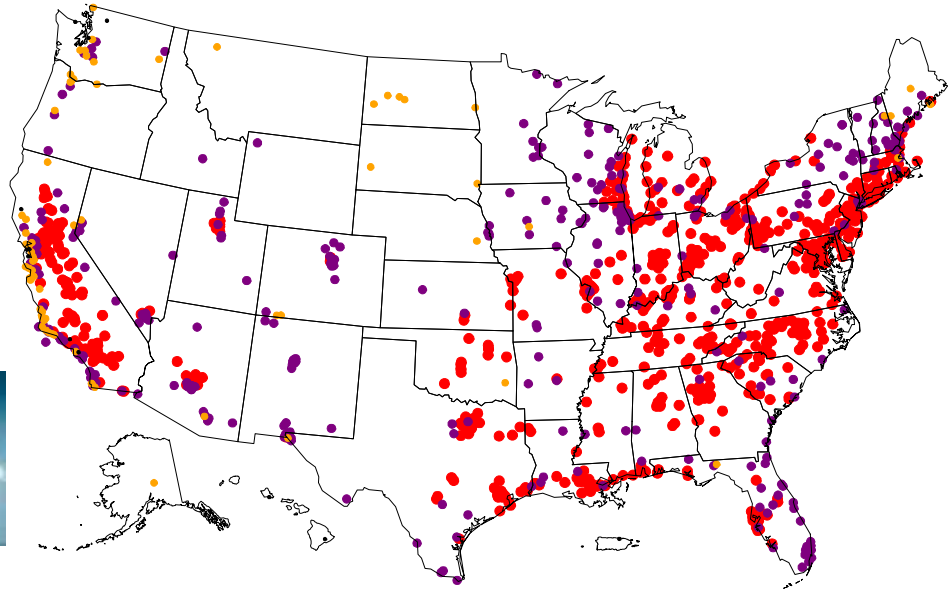
What is the National analysis? - Cont.

1. Evaluation of each sites' 'percent of NAAQS'

SO2 Annual Mean

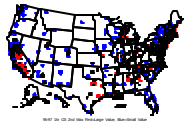
SO2 Annual Mean Percent of NAAQS:Red= >100%, Purple= 80-100%, Orange= 60-80%, Black= <60%

98-00 8-Hour O3 2nd Max



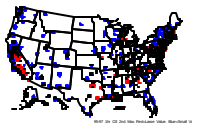
98-00 8-Hour O3 2nd Max Percent of NAAQS:Red= >100%, Purple= 80-100%, Orange= 60-80%, Black= <60%

In general, we have 2 pollutant National problem: $PM_{2.5}$ & Ozone. Other Criteria mainly hot-spot issues.



Monitoring Strategy:

'National' Analysis



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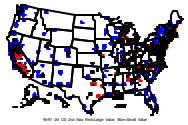
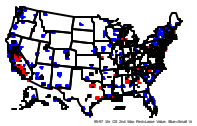


Monitoring Strategy:

'National' Analysis

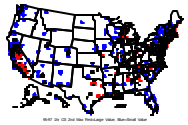


What is the National analysis? - Cont.

2. Multi-objective 'information value' approach ~ Ranked each site (by pollutant / metric) according to 5 measures: **I) Concentration, II) Uncertainty, III) Deviation from NAAQS, IV) Area represented, and V) Population represented.** The measure rankings were then aggregated based on different weighting schemes and composite maps produced.

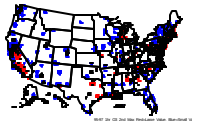
The five different measures represent the information need for (1) population exposure / AQI, (2) compliance monitoring and (3) tracking / model evaluation. The methodology allows easy incorporation of additional measures.

AQ Management Activity	**Geographic Info. Need**
Risk assessment	Pollutant concentration
Risk Assessment	Persons/Station
Compliance evaluation	Conc. vicinity to NAAQS
Reg./local source attribution, tracking and model evaluation	Spatial coverage
All above	Estimation uncertainty



Monitoring Strategy:

'National' Analysis



What is the National analysis? - Cont.

2. Multi-objective 'information value' approach ~ Ranked each site (by pollutant / metric) according to 5 measures. Mapped rankings by Quartile.
    I. **Concentration** (ppb, ug/m3...) - the higher the concentration, the more valuable the site for NAAQS usage, exposure, etc.

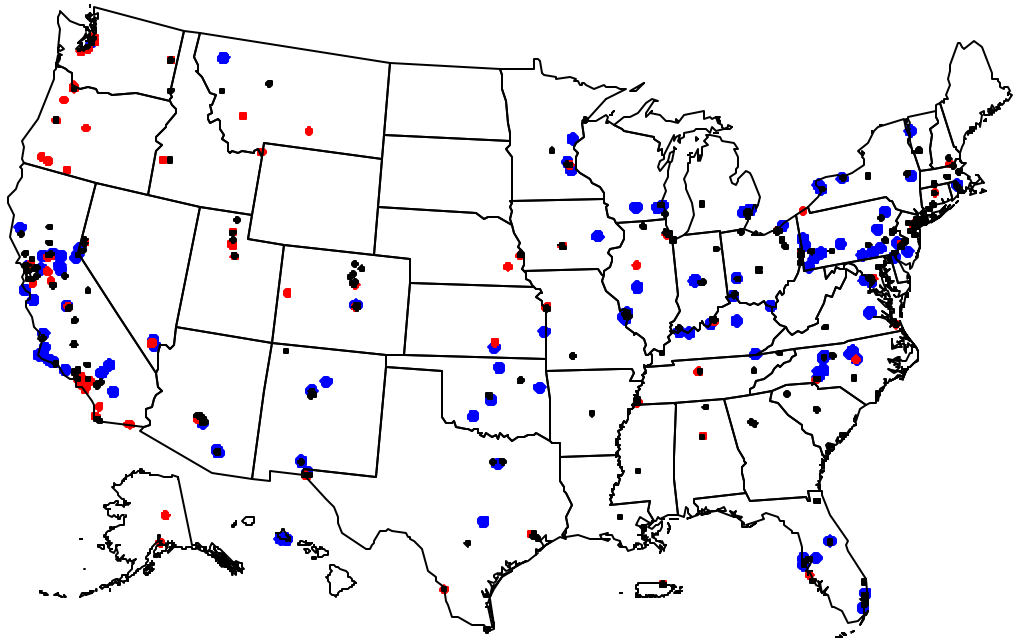
Color scheme used on all maps (for all 5 measures):

Red = top quartile

Black = middle quartiles

Blue = bottom quartile

8-Hour CO 2nd Max: Red=Large Value, Blue=Small Value



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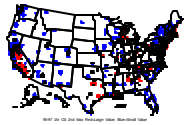
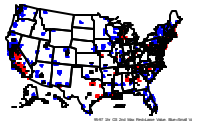


Monitoring Strategy:

'National' Analysis

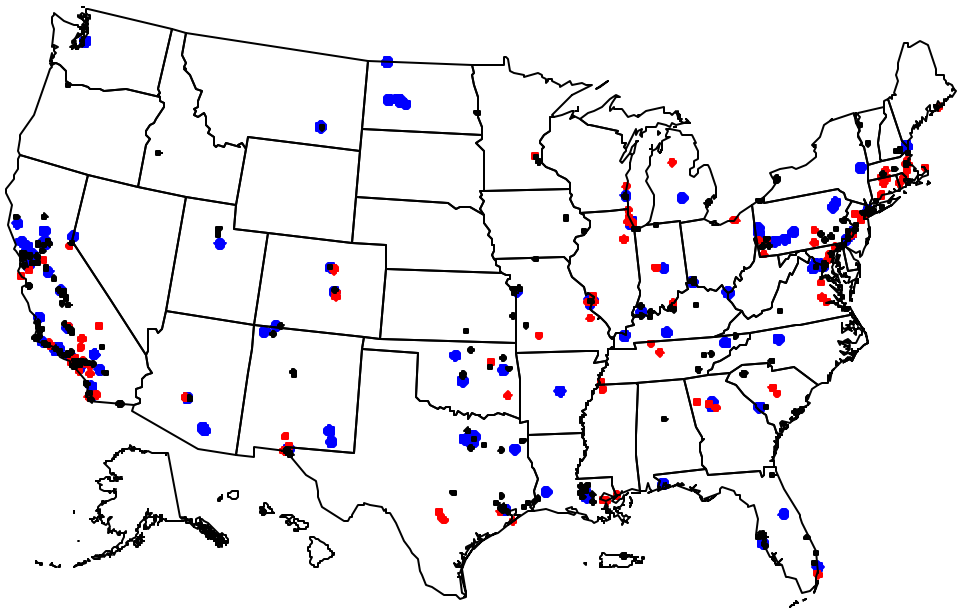


What is the National analysis? - Cont.

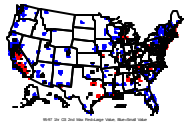
2. Multi-objective 'information value' approach ~ Ranked each site (by pollutant / metric) according to 5 measures.
   II. **Uncertainty** (/estimated-actual/) - the greater the uncertainty in the 'design value', the more valuable the site. If a site wasn't present in a particular location, how well could the concentration metric (for that location) be estimated based on surrounding sites. Measure of 'uniqueness'; don't need redundant sites

- *The station with the highest deviation between the actual and the estimated values (i.e. estimation uncertainty) is ranked #1.*
- *The estimation uncertainty depends on the spatial extrapolation method. The spatial extrapolation method used here is a declustered, inverse distance weighed scheme developed by CAPITA.*

Predicting NO2 Annual Mean:

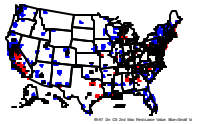


Predicting NO2 Annual Mean: Red=High Uncertainty, Blue=Low Uncertainty



Monitoring Strategy:

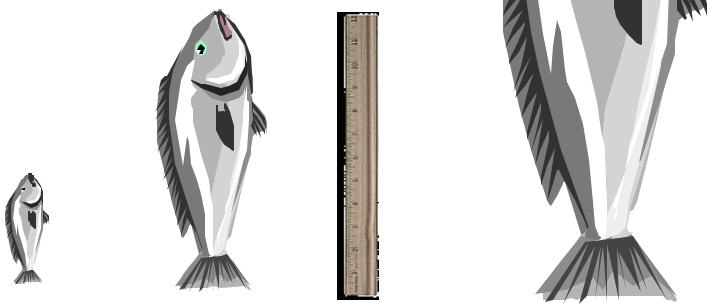
'National' Analysis



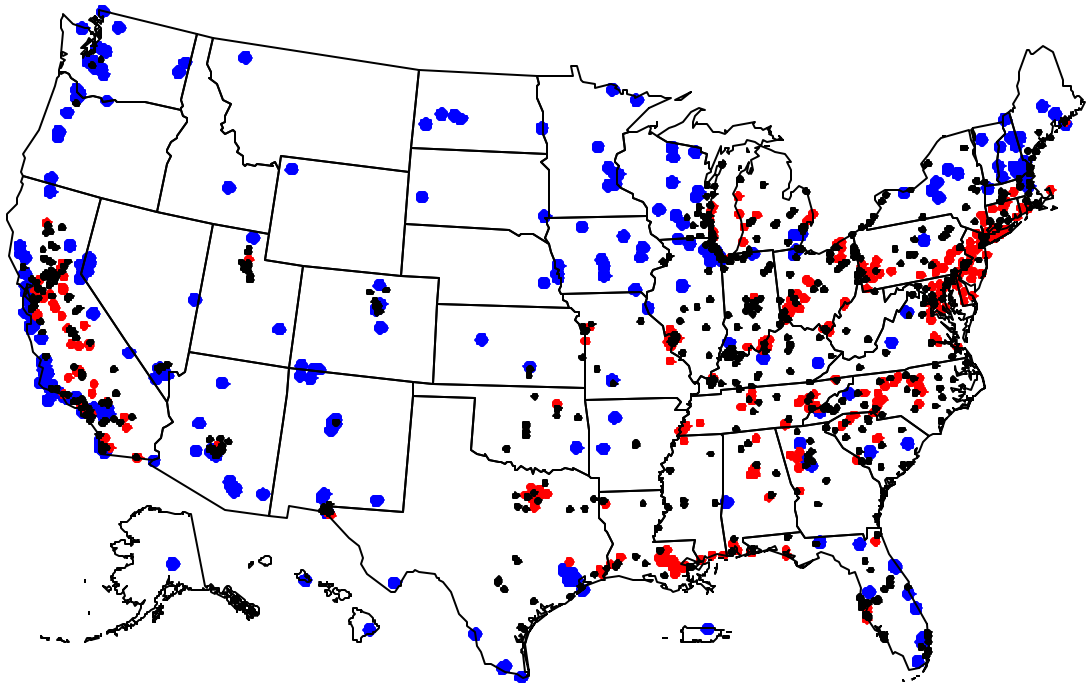
What is the National analysis? - Cont.

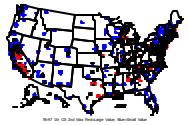
2. Multi-objective 'information value' approach ~ Ranked each site (by pollutant / metric) according to 5 measures.
   III. **Deviation from NAAQS** (/3yr dv - standard/) - the smaller the deviation the higher the rank. If a site is very close to the NAAQS (too close to call based on estimation), the site is probably needed to determine attainment or not.

- *Deviation from NAAQS measures the station's value for compliance evaluation.*
- *The station ranking is according to the absolute difference between the station value and the NAAQS.*
- *The station whose concentration is closest to the standard (smallest deviation) is ranked #1.*



Deviation from 1-hr O3 2nd Max NAAQS (98-00):





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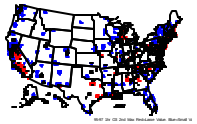
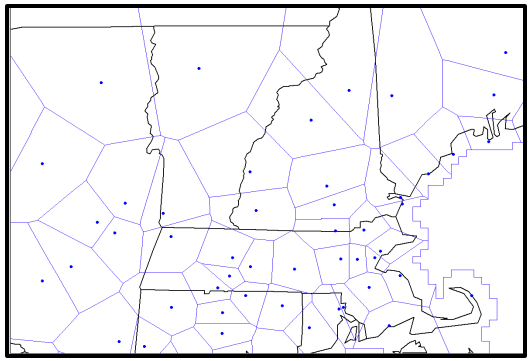


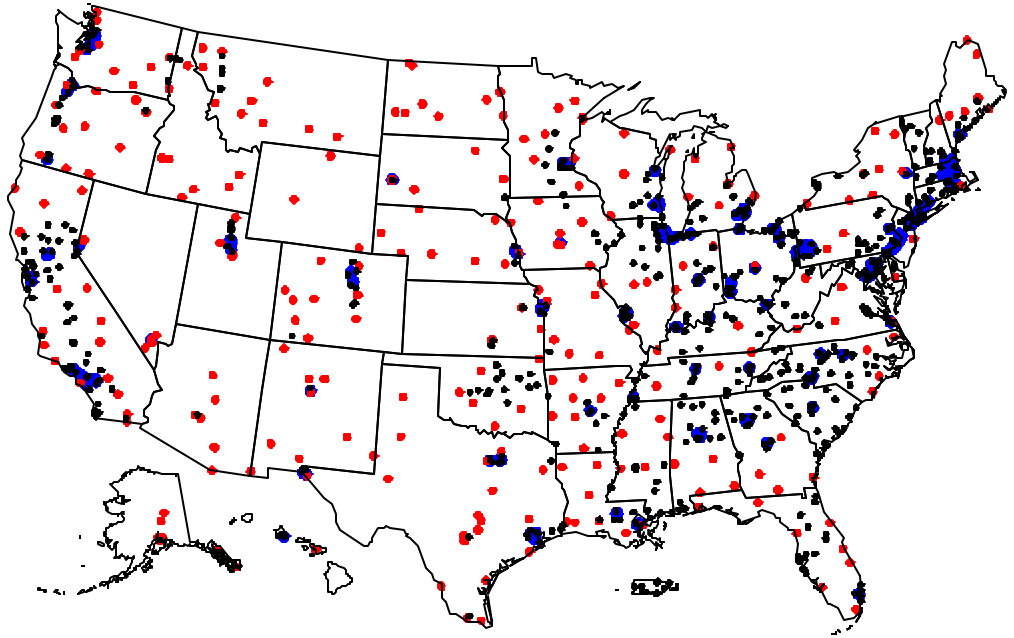
What is the National analysis? - Cont.

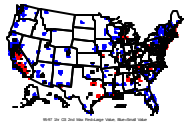
2. Multi-objective 'information value' approach ~ Ranked each site (by pollutant / metric) according to 5 measures.
   IV. **Area of sampling zone** (km2) - measures the geographic surface area each station covers. The highest ranking is for the station with the largest area in it's sampling zone. This measure assigns high relative value to remote regional sites and low value to clustered urban sites with small sampling zones.

- *Every location on the map is assigned to the **closest monitoring station**.*
- *At the boundaries the distance to two stations is equal.*
- *Following the above rules, the 'sampling zone' surrounding each site is a **polygon**.*
- *The **area** (km^2) of each polygon **is calculated.***



Area for PM25 Monitors





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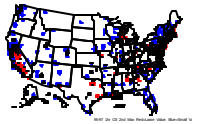
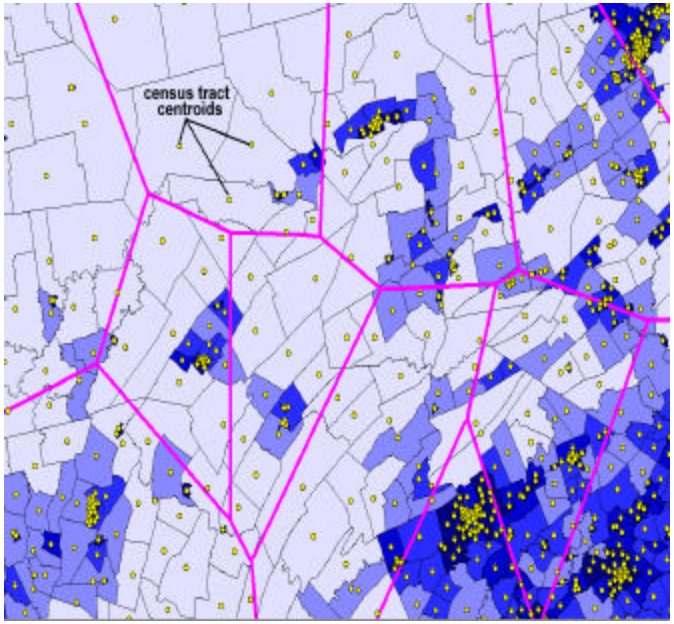


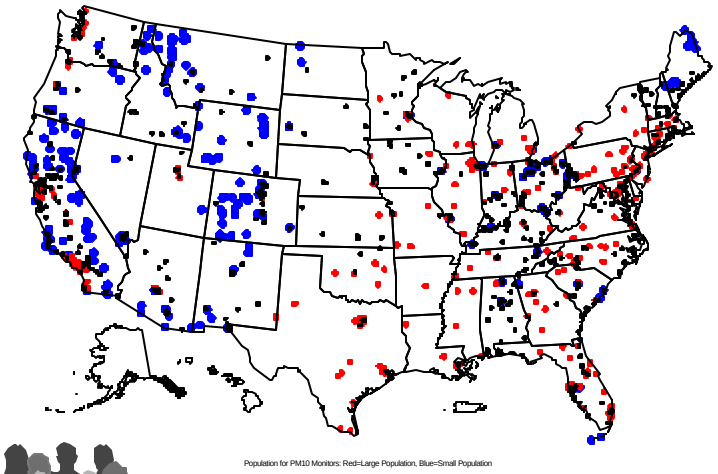
What is the National analysis? - Cont.

2. Multi-objective 'information value' approach ~ Ranked each site (by pollutant / metric) according to 5 measures.
   V. **Population represented** (persons / station) - the greater the population, the more important the site. The representative population for a monitor is calculated in three steps: 1) Population data (1999) at the census tract were obtained; 2) The population from each census tract was assigned to a specific station's sampling zone; 3) The sum of all census tracts in a station sampling zone was calculated.

- *The population data used for determining a station's population is from ESRI's census tract file with estimated 1999 populations.*
- *The centroid of each census tract is associated with a station area (polygon).*
- *The census tract populations for all centroids that fall within a station's area are summed.*

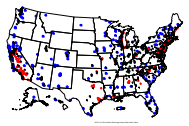


Population for PM10 Monitors



Monitoring Strategy:

'National' Analysis

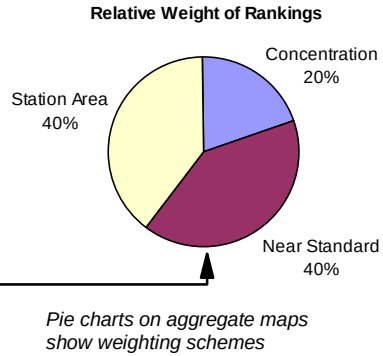


What is the National analysis? - Cont.

2. Multi-objective 'information value' approach ~ Ranked each site (by pollutant / metric) according to 5 measures. *The measure rankings were then aggregated based on different weighting schemes and composite maps produced.*

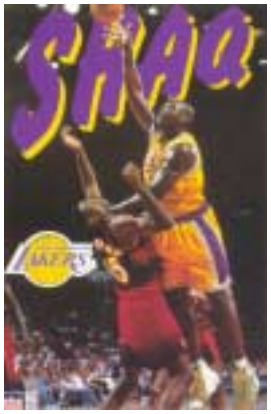
weighting is subjective!

	Concentration	Uncertainty	Deviation from NAAQS	Area	Population
W1: equal weights	20%	20%	20%	20%	20%
W2: NAAQS Compliance	30%	30%	5%	5%	5%
W3: Exposure / AQI	30%	5%	5%	30%	30%
W4: ?	50%	50%	0	0	0
W5: Emissions tracking/model evaluation	20%	40%	0	40%	0



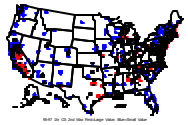
Pie charts on aggregate maps show weighting schemes

How the measures are weighted affects the final ranking!



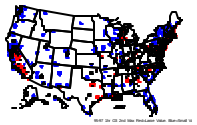
Points: 28.7 per game (3rd in NBA)
Rebounds: 12.7 per game (4th in NBA)
Field goal percent: 57.2 (3rd in NBA)
Blocked shots: 2.8 per game (4th in NBA)
Free throw percent: 51.3 (near bottom of NBA)

- What is the main objective of the network / site?
- Is it meeting that objective?



Monitoring Strategy:

'National' Analysis



What is the National analysis? - Cont.

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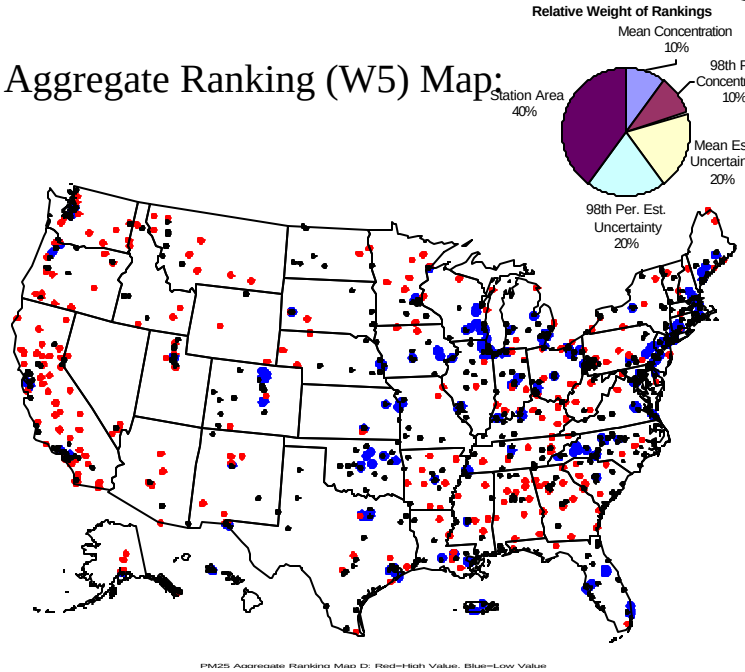
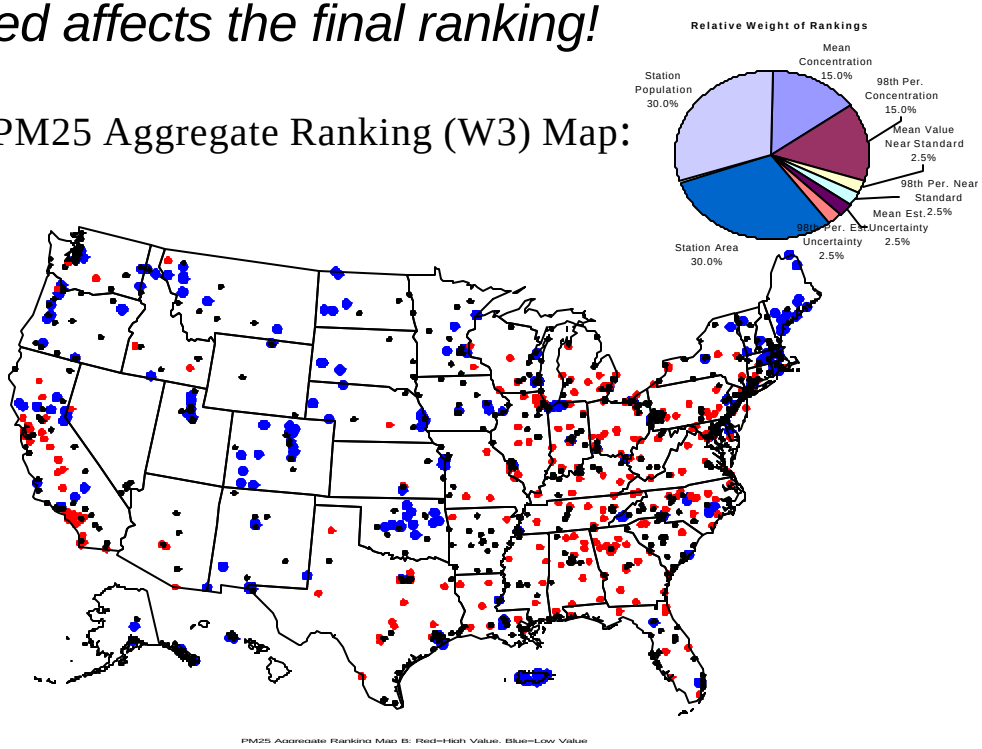
How the measures are weighted affects the final ranking!

PM25 Aggregate Ranking (W5) Map:

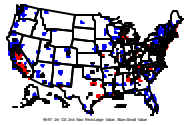


Emissions tracking/model evaluation

PM25 Aggregate Ranking (W3) Map:

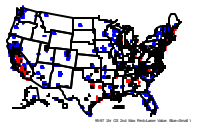


Exposure / AQI



Monitoring Strategy:

'National' Analysis



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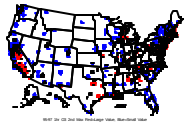
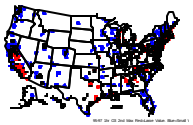
- Three central pieces:
  1. Evaluation of each sites' ‘percent of NAAQS’
  2. Multi-objective 'information value’ approach ~ Shows relative value of each site according to different monitoring objectives ~ Ranked each site (by pollutant / metric) according to 5 measures [Concentration, Uncertainty, Deviation from NAAQS, Area represented by Site, & Population represented by site]. The measure rankings were then aggregated based on different weighting schemes and composite maps produced.
  3. Trends evaluation: Looked at 5-year and 10-year trends ('91-'00 & '96-'00)



Monitoring Strategy:

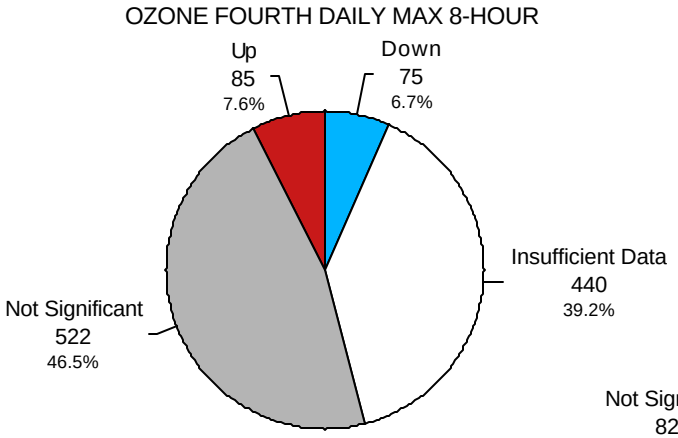
'National' Analysis

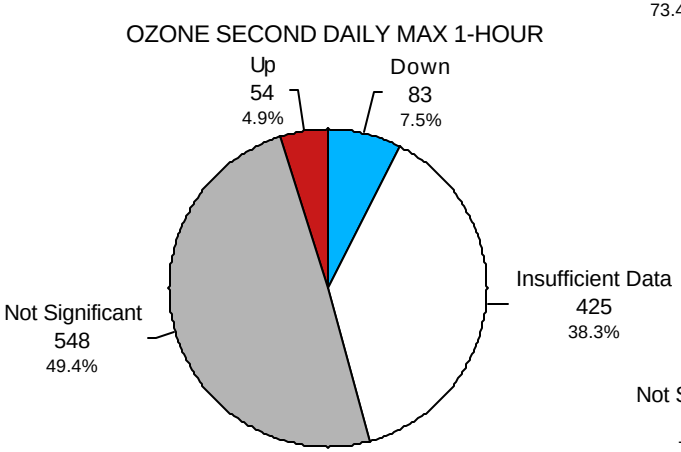


What is the National analysis? - Cont.

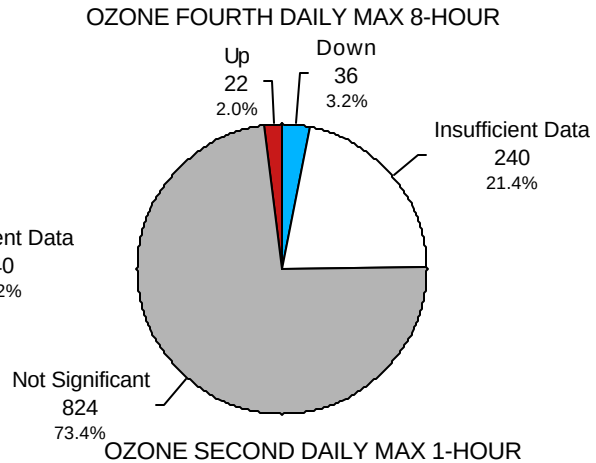
3. Trends evaluation: Looked at 5-year and 10-year trends
   - Identified and summarized site trends
     - Used same non-parametric trend routine utilized in Trends Report

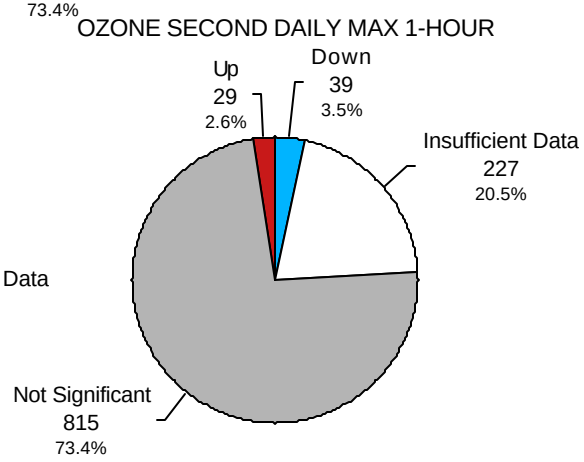
O3 10-Year Trend



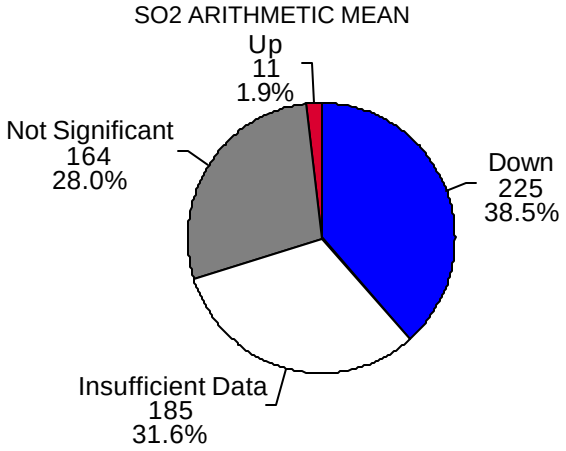


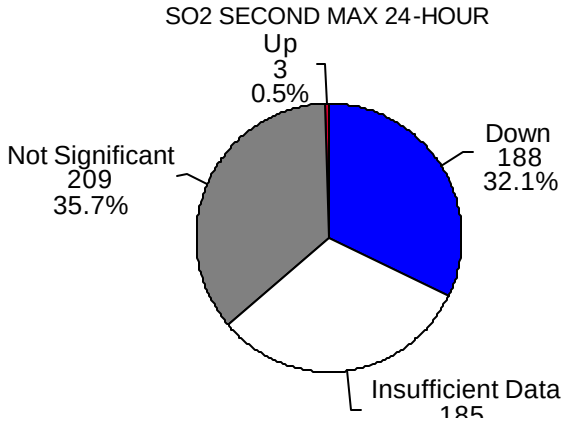
O3 5-Year Trend

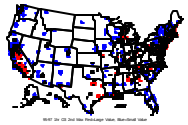




SO2 10-Year Trend

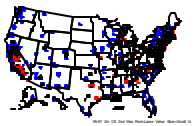






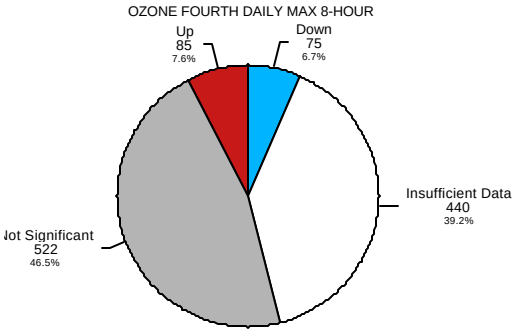
Monitoring Strategy:

'National' Analysis

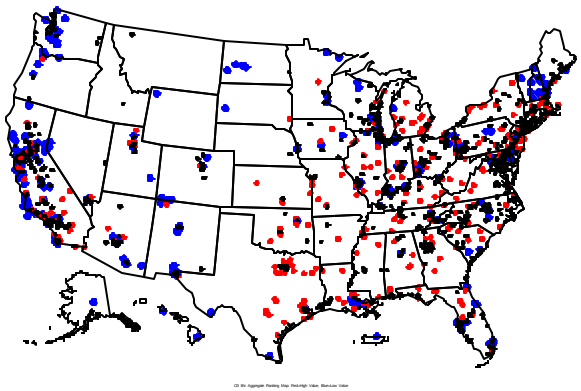


What is the National analysis? - Cont.

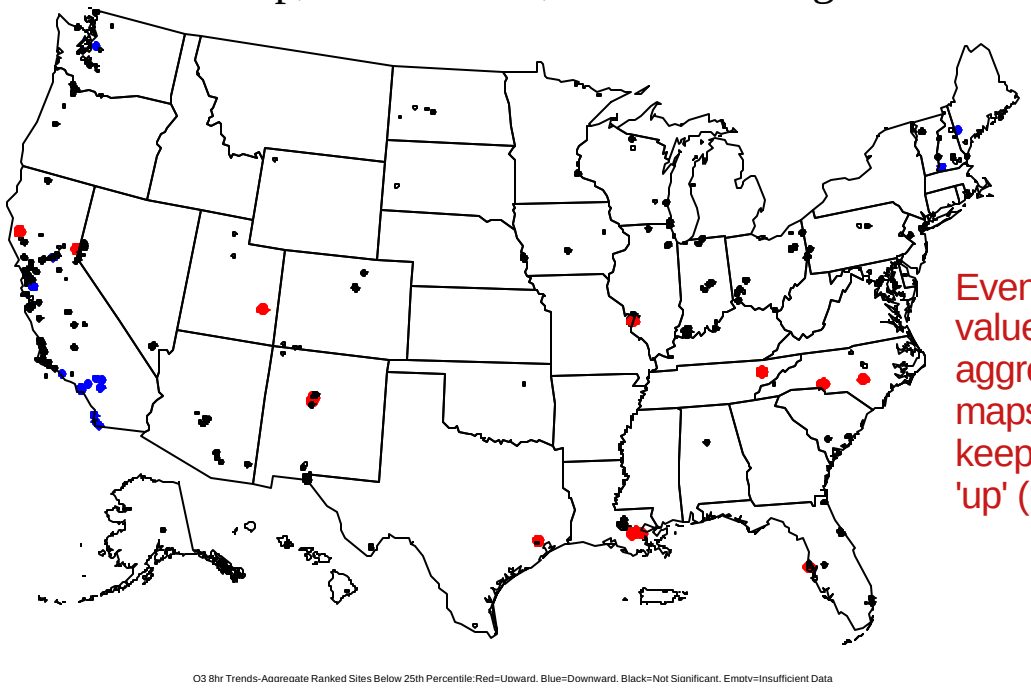
3. Trends evaluation: Looked at 5-year and 10-year trends
   - Merged Trend information with 'information value' (#2) analysis



8-Hour O3 Aggregate Ranking Map:
Red=High Value, Blue=Low Value

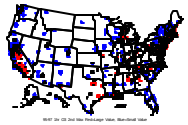


8-hr O3 10-yr Trends - Aggregate Ranked (Equal Weighting) Sites in 4th Quartile (Least Important):
Red=Up, Blue=Down, Black=Not Significant ← Not quartiles!

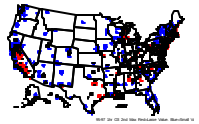


O3 8hr Trends-Aggregate Ranked Sites Below 25th Percentile:Red=Upward, Blue=Downward, Black=Not Significant, Empty=Insufficient Data

Even if a site is 'low value' (blue) in aggregate measure maps, you may want to keep if its data trend is 'up' (red on this map)

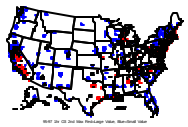


Monitoring Strategy:
'National' Analysis



Who? When? Where?

- Who did the analyses:
  - Rudy Husar / Stefan Falke of CAPITA (Center for Air Pollution Impact and Trend Analysis) developed base concept and ozone prototype; and ran uncertainty (spatial interpolation), calculated the areas (zones of influence), and corresponding populations.
  - AQTAG & MQAG created input data files; ran other measures, percent of NAAQS, and trends; and made maps
  - National Monitoring Strategy Committee (Scheffe, Koerber, etc.) provided guidance (e.g, what years to use), developed weighting schemes.....
- When was the analyses done?
  - Prototype delivered December '00; final analyses July '01
- **Where can you find the analyses?**
  - AMTIC > National Air Monitoring Strategy Information > Network Assessments and Maps **http://www.epa.gov/ttn/amtic/netamap.html**
    - Outputs from the National Network Assessment Introduction and Explanation-File #1
    - Outputs from the National Network Assessment Results-File #2
    - Outputs from the National Network Assessment Results-File #3
    - Outputs from the National Network Assessment Results (ozone regional maps) -File #4
    - Outputs from the National Network Assessment Results (PM2.5 regional maps)-File #5
    - Inputs to the National Network Assessment Pollutant site files in Excel format



Monitoring Strategy: *'National' Analysis*

What does the National analysis show? (General Interpretations)

- **"Clearly, two criteria pollutants, ozone and PM2.5, dominate the nation's air quality with respect to elevated concentrations."**
- **"These results reinforce our general understanding of the surplus of monitoring sites for criteria pollutants for which substantial progress has been achieved in reducing concentrations of CO, SO2, NO2, Pb and PM10 over the last 20 years. "**

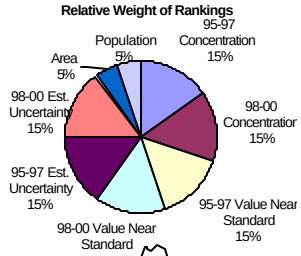
Ozone

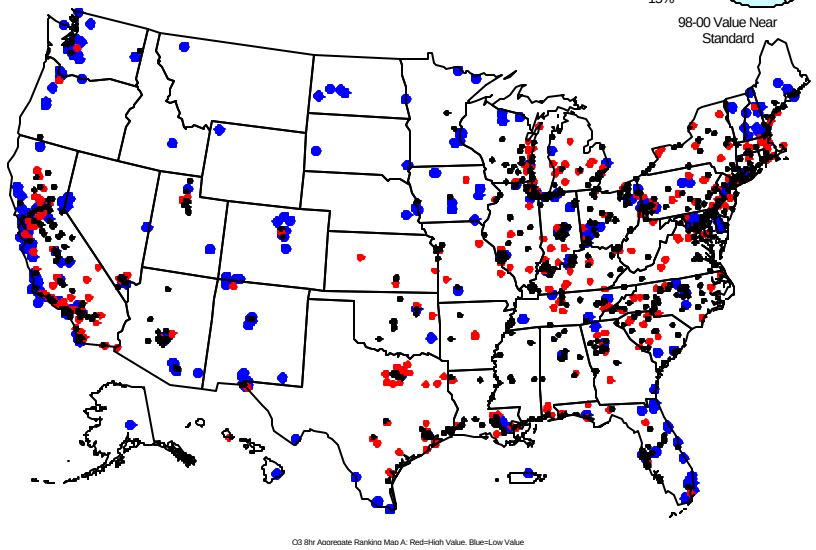
"From a national perspective, a minor reduction (5-35%) in the number of ozone sites (e.g., from urban clusters) is recommended. *This reduction in the current network would not compromise our ability to address NAAQS compliance, provide input for public reporting needs (AQI, AIRNOW) or assess effectiveness of emissions control programs, including evaluation of air quality models. All of these* ***objectives would be better served by using any resource gains from such a reduction to position ozone monitors in areas with current "high" measurement uncertainties, locations typically outside the existing MSA of interest.*** *The relocation should be guided by considering results of interpolated error regimes , air quality model output indicating expected spatial gradients and the collective knowledge of local monitoring experts that can address the logistics of site procurement and operation."*

:

All major metropolitan areas with clustered ozone sites should consider removing those sites that provide only minimal relative value compared to other sites in the cluster. Examples include Chicago, major Eastern cities (New York, Boston, Philadelphia, Pittsburgh, Baltimore-D.C) and major California cities...

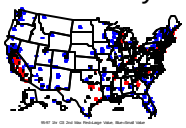
8-Hour O3 Aggregate Ranking Map:
Red=High Value, Blue=Low Value





O3 8hr Aggregate Ranking Map A: Red=High Value, Blue=Low Value

National Analyses



Monitoring Experience

Modeling Experience

Bank of U.S.A.

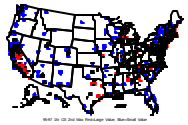
Pay to: National Monitoring **$** ???

??? Million Dollars ----------

Uncle Sam

National Recommendations

1. Cut
2. Add
3. Modify



Monitoring Strategy:

'National' Analysis

What does the National analysis show? (General Interpretations) - cont.

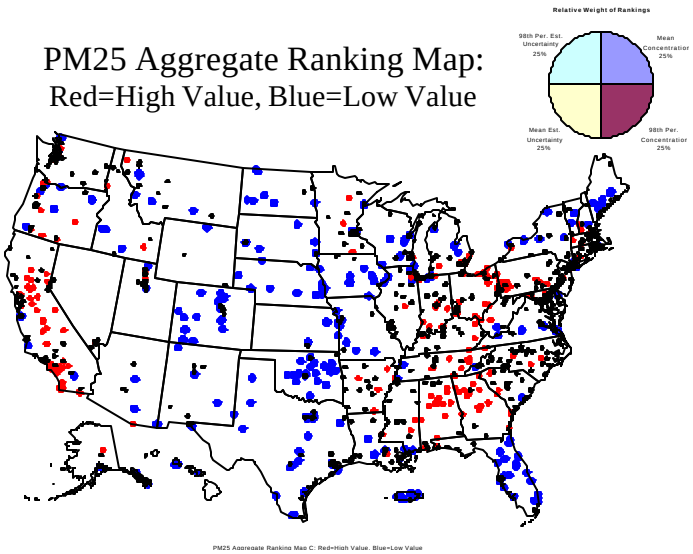
PM2.5

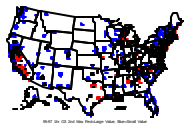
"From a national perspective, a significant reduction (up to 35%) in the number of PM2.5 FRM monitors is recommended. *This reduction in the current network would not compromise our ability to meet the principal data quality objective of addressing NAAQS compliance. It is assumed that the existing FRM network will be maintained through the end of 2002 or until three full calendar years of data are collected, whichever is later. (The only exceptions to this might be to: (1) relax the sampling frequency to 1-in-6 day at sites where the annual NAAQS is controlling, and (2) eliminate low concentration, redundant FRM monitors, if resources are needed now to support deployment of speciation or continuous monitors.)* ***After the end of 2002, or when three full calendar years of data are available, then a significant reduction in the number of FRM monitors to something on the order of 700 – 800 sites nationally should be considered.*** *Because the FRM filter-based technology will not, however, meet the needs for timely data reporting (e.g., AQI and AIRNOW), a substantial effort must be put forth to implement continuous PM monitors that produce acceptable data quality into the network to meet multiple data analyses. Eventually, the number of integrated FRMs can be reduced further in parallel with the incorporation of PM continuous instruments that produce a successful record of meeting specified performance standards. EPA must accelerate the production of guidance for identifying redundant FRM sites for removal, the development of DQO's and performance standards that will facilitate introduction of continuous methods, and associated regulatory changes to accommodate these technical adjustments.*

:

In addition, ***several areas of the country including New England, upstate New York, Florida and much of the north central states and west outside California*** *do not exhibit elevated PM2.5 concentrations. Those areas should review their network paying careful attention to optimizing sites that* ***emphasize characterizing background and gradient patterns and public reporting more than NAAQS compliance."***

PM25 Aggregate Ranking Map:
Red=High Value, Blue=Low Value





Monitoring Strategy:

'National' Analysis

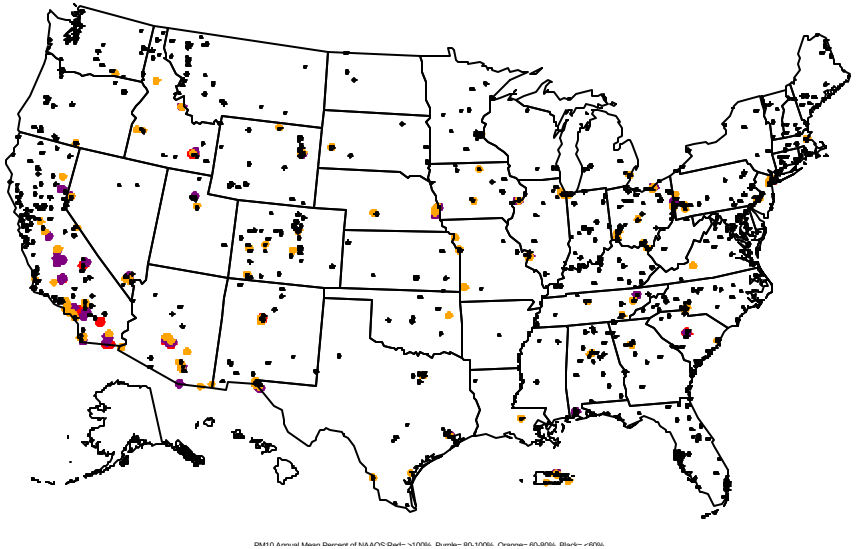
What does the National analysis show? (General Interpretations) - cont.

PM10

"A major reduction (50-80%) in the number of PM10 monitors is recommended. *Only those sites that have current PM10 exceedances and violations, as well as those required as part of SIP approval conditions should remain as priority sites. Any additional PM10 monitoring should be conducted at locations collocated with a PM2.5 FRM, with suspected "elevated" PM-coarse concentrations, and with measurement technology compatible with the PM2.5 FRM.* ***Clearly, opportunities for reduction are far greater in Eastern Regions of the country."***

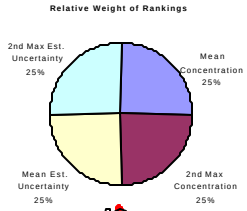
PM10 Annual Mean - Percent of NAAQS:

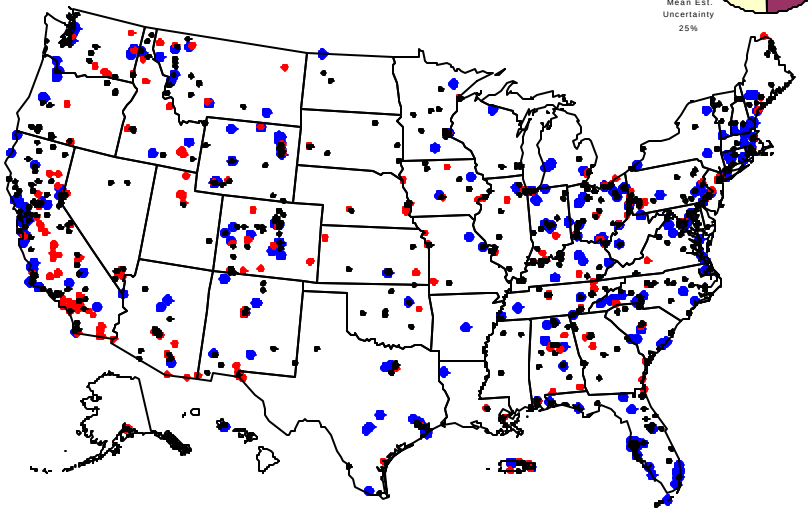
Red= >100%, Purple= 80-100%,
Orange= 60-80%, Black= <60%

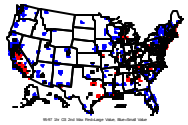


PM10 Aggregate Ranking Map:

Red=High Value, Blue=Low Value







Monitoring Strategy:

'National' Analysis

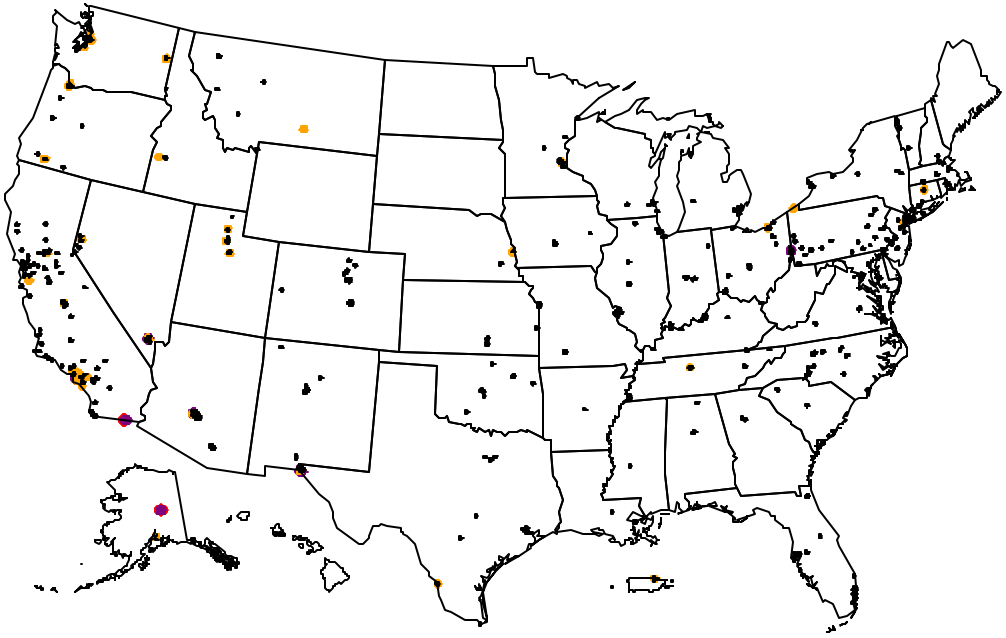
What does the National analysis show? (General Interpretations) - cont.

CO

"A major reduction (approximately 50- 80%) in the number of CO monitors is recommended. *Only those sites tha have current CO exceedances and violations, as well as those required as part of SIP approval conditions should remain a priority sites. Existing CO monitors located in urban microscale sites should be* ***relocated to more broadly representative urban locations****. In addition, CO monitoring should be* ***conducted using high resolution instruments i rural areas to provide regional information about CO concentrations, as may be needed to evaluate air quality models and apply observation-based methods (OBMs)."***

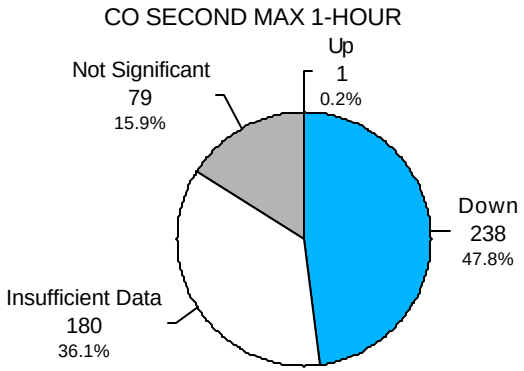
8-Hour CO 2nd Max - Percent of NAAQS:

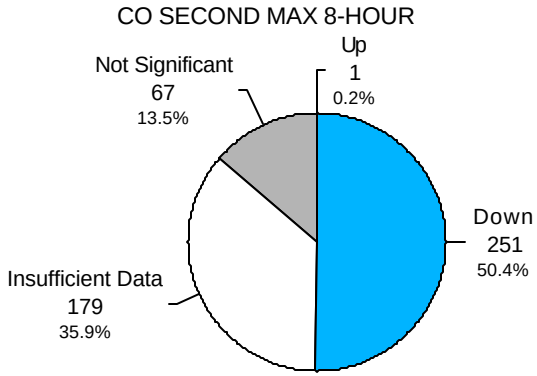
Red= >100%, Purple= 80-100%,
Orange= 60-80%, Black= <60%

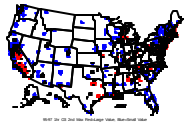


8-Hour CO 2nd Max Percent of NAAQS:Red= >100%, Purple= 80-100%, Orange= 60-80%, Black= <60%

CO 10-Year Trend







Monitoring Strategy:

'National' Analysis

What does the National analysis show? (General Interpretations) - cont.

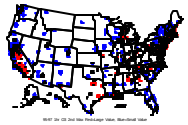
NO2

"The current NO2 network should be reduced approximately 90% to include only those sites identified by EPA as critical for national trends and those sites identified as supporting model evaluation and emissions tracking needs. This divestment should be complemented by investing in high resolution NOy/NO sites placed in regionally representative areas for model evaluation and tracking of emission reduction programs"

NO2 Annual Mean - Percent of NAAQS:

Red= >100%, Purple= 80-100%,
Orange= 60-80%, Black= <60%

NO2 Annual Mean Percent of NAAQS:Red= >100%. Purple= 80-100%. Oranae= 60-80%. Black= <60%



Monitoring Strategy:

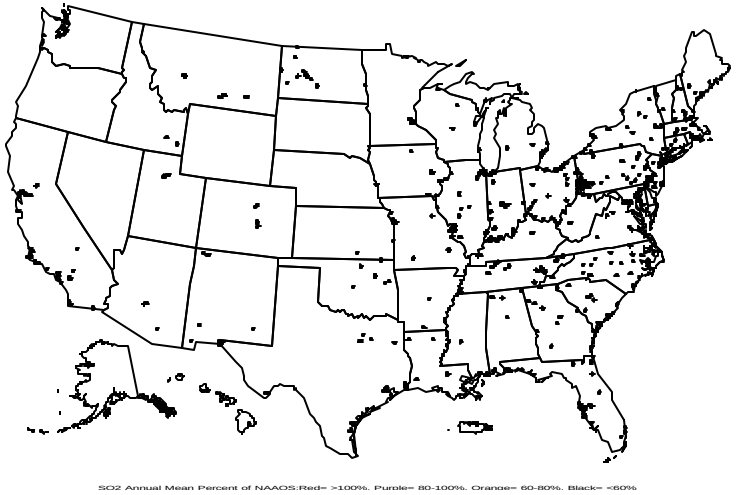
'National' Analysis

What does the National analysis show? (General Interpretations) - cont.

SO2

"The SO2 network shares similarities to those in the CO network in that the network design was specifically source oriented. ***The SO2 network in its current form should be reduced substantially (approximately 50-80%) nationwide.*** *As with CO, those important compliance sites should be retained and a fundamental rethinking of network design for SO2 be considered. A* ***small select number of sites are being adjusted to address 5 minute averging times in response to concerns regarding short term SO2 exposures.*** *As a major precursor for PM2.5, very little relevant SO2 data exists that allows for evaluation of air quality models or to support observational methods that rely on formation rate principles (CO and N species are also useful).* ***Investments in SO2 should be made in monitors capable of reading background concentrations and siting in areas with larger spatial scale representativeness*** *collocated with other coupled atmospheric process and health related measurements."*

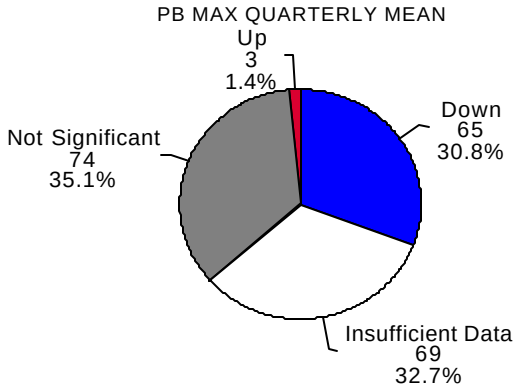
SO2 Annual Mean - Percent of NAAQS:
Red= >100%, Purple= 80-100%,
Orange= 60-80%, Black= <60%

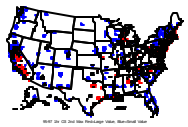


Pb

"Progress in the reduction of Lead concentrations is a clear air program success story. Basically, we should declare victory and ***limit lead monitoring to those isolated areas influenced by significant stationary sources****, and* ***maintain those sites identified by EPA to be retained for long term trends."***

10-Year Pb Trend

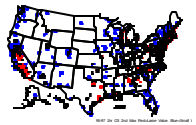




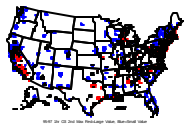
Monitoring Strategy:

'National' Analysis

Caveats / Criticisms

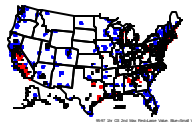


- Regional/local assessments required for site specific recommendations
  - They “over rule” national results
- Limited applicability due to national scale, e.g.:
  - Rationale in comparing NE O3 with NW O3?
  - uneven site spatial scales compromise error and spatial assumptions for CO and PM10
- Too much emphasis on high concentrations
  - Compromise value of background, gradient sites for model evaluation and other needs
- Subjectivity in weighting measures
- Absence of policy realities
- Recommendations still are not supported firmly by quantitative results
- More analysis work… or reached limit of a national analysis?



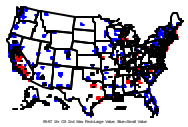
Monitoring Strategy:

'National' Analysis



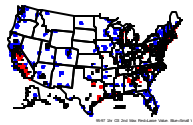
Caveats / Criticisms

- Years used: The 'percent of NAAQS' and 'info value' analyses should not have been limited to only 1998-2000 (&1995-1997 O3)
- Real design values should have been used (exceedance vs concentration, actual vs estimated, 2yr for CO, etc.)
- The 'uncertainty' methodology is too simplistic
- A daily 'uncertainty' measure (to account for AQI, etc.) should also have been included
- A 'NAAQS designation' factor (e.g. number of sites in county) should have been included
- The 'sampling zone' polygons are meaningless. Something else (e.g., distance to nearest site) should have been used instead
- Non-FRM lead monitors were accidentally included
- Incomplete data were used for some sites
- The pollutant by pollutant analyses is not applicable to sites that monitor multiple criteria pollutants ~ a collocation factor should have been included
- Fuchsia squares should have been used in lieu of blue circles



Monitoring Strategy:

'National' Analysis



Follow-up activities

- "All EPA regional offices, in conjunction with the states, tribes, and any multi-state organizations in that region, should undertake a regional/local assessment to complement this national assessment. **These regional/local assessments should be delivered to OAQPS by 9/1/02** and should include an interpretation of this national assessment as it affects their region, and proposed regional network modifications that are either consistent with this assessment or reflect more refined assessments conducted for their region."
- Portable network design software (Design Interface) ~ a tool for Regions/States/Tribes
  - Runs on S-Plus
  - 'Working' beta version available
  - Enhancements funded; work to start soon
- ORD Cooperative Agreement (w/ Duke, NCSU stat professors)
  - Statistical methodology for network design. [E.g., 'Network Selection Using Entropy']
- Spatial Data Analysis Technical Exchange Workshop
  - 2 ½ days ~ December 3-5, 2001 in RTP
- Various EMAD analysis